

The logo for the Office of Environmental Health Hazard Assessment (OEHHA) features the acronym "OEHHA" in a bold, black, sans-serif font at the top. Below the text is a circular emblem containing a stylized green leaf or plant motif, with a white swoosh element that suggests a protective shield or a natural cycle.

Technical Support Document: Toxicology Clandestine Drug Labs: Methamphetamine

Volume 1, Number 8

METHAMPHETAMINE

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Introduction

The clandestine synthesis of methamphetamine (meth) and other illegal drugs is a growing public health and environmental concern. For every pound of meth synthesized there are six or more pounds of hazardous materials or chemicals produced. These are often left on the premises, dumped down local septic systems, or illegally dumped in backyards, open spaces, in ditches along roadways or down municipal sewer systems. In addition to concerns for peace officer safety and health, there is increasing concern about potential health impacts on the public and on unknowing inhabitants, including children and the elderly, who subsequently occupy dwellings where illegal drug labs have been located.

The Office of Environmental Health Hazard Assessment (OEHHA), in cooperation with the Department of Toxic Substances Control (DTSC), has been charged with assisting in identifying and characterizing chemicals used or produced in the illegal manufacturing of methamphetamine, which pose the greatest potential human health concerns. To address in part this growing environmental problem and the need for public health and safety professionals to make appropriate risk management decisions for the remediation of former methamphetamine laboratory sites, OEHHA has developed two types of chemical-specific information documents.

The first set, technical support documents (TSDs), are referenced, multi-page publications, which contain important health and safety data, exposure limits, and key information for recognizing chemicals used or produced during the manufacturing of methamphetamine. These documents will likely be most helpful to health and safety officers, industrial hygienists, or others interested in more detailed toxicological information. The second set, two-page fact sheets, contain much of the same information as the corresponding TSDs; however, the details are presented in a more succinct, graphical format. The fact sheets will be helpful to individuals, including the public, who want to be able to quickly recognize potential chemicals of concern found in illegal methamphetamine labs in order to avoid inadvertent exposures and resulting health impacts.

For more information or to obtain copies of these and other documents, contact:

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OFFICE OF ENVIRONMENTAL
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I. Chemical Name

A. METHAMPHETAMINE (C₁₀H₁₅N)

B. Synonyms

Methamphetamine hydrochloride solid salt form: benzeneethanamine, N-alpha-dimethyl-phenylethylamine hydrochloride, *d*-deoxyephedrine hydrochloride, *d*-desoxyephedrine hydrochloride (Merck, 1996). Trade names include Desoxyn®, Methampex®, Methedrine®, Pervitin®, Temmler® and Norodin® (Makalinao & Aguirre, 1993). Street names include Speed, Meth, Ice, Crank, Crystal, CR, Vitamin C, Go-fast, Chalk, Glass, Amps, Batu, Chicken Powder, Cristina, Croak (mixture with cocaine), Dice, Doe, LA Glass, Monster, Peanut Butter Crank, Shabu, Yaba (mixture with caffeine), Snot (Infotext, 2003; MDL, 2001; Merck, 1996; Stalcup, 2001).

II. Role in Clandestine Drug Synthesis: Methamphetamine

Methamphetamine is the final desired product in the synthesis process.

III. Chemical Description

Clandestine laboratories produce two chemical forms of methamphetamine, the free base ("methamphetamine base") and the hydrochloride salt ("methamphetamine hydrochloride"). The free base, which is the initial product of a clandestine synthesis, is a liquid at room temperature. At alkaline pH, the free base of methamphetamine is soluble in organic solvents. The hydrochloride salt is produced from the free base by bubbling hydrogen chloride gas through a solution of the free base. Methamphetamine contains one optically active carbon atom. Consequently, there are two isomeric forms of methamphetamine, called *d*-methamphetamine and *l*-methamphetamine. The *d*-isomer is more potent than the *l*-isomer, and virtually all of the methamphetamine produced by clandestine laboratories is the *d*-isomer.

A. Appearance

Methamphetamine hydrochloride is usually found as a yellow or white crystalline powder; however, "street" grade methamphetamine may be found in a variety of colors (Stalcup, 2001; Turkington, 2000). Methamphetamine hydrochloride may also be found as "ice," a large, usually clear crystal of high purity. Methamphetamine base is a yellow to brown liquid (Turkington, 2000).

B. Taste

Methamphetamine hydrochloride has a bitter taste (Makalinao & Aguirre, 1993).

C. Odor

Methamphetamine hydrochloride is odorless (Turkington, 2000). Methamphetamine base has a sharp biting odor resembling geranium leaves (HSDB, 2002; Turkington, 2000).

D. Odor Threshold

Methamphetamine hydrochloride (MDL, 2001): Not applicable.

Methamphetamine base: Not available.

E. Irritancy Threshold

Methamphetamine hydrochloride (MDL, 2001): Not available.

Methamphetamine base: Not available.

F. Odor Safety Class

Methamphetamine hydrochloride (MDL, 2001): Not applicable.

Methamphetamine base: Not available.

G. Vapor Density

Methamphetamine hydrochloride (MDL, 2001): Not applicable.

Methamphetamine base: Not available.

H. Vapor Pressure

Methamphetamine hydrochloride (MDL, 2001): Not applicable.

Methamphetamine base: 0.163 mmHg @ 25° C (Neely & Blau, 1985).

IV. Containers and Packaging

A. Commercial Products

d- Methamphetamine is a controlled substance in the United States (Drug Enforcement Agency, Schedule C). It is only available by prescription for legitimate medical uses. *l*- Methamphetamine is used in Vicks® Vapor Inhaler as a nasal decongestant (PDR, 2002).

B. Pharmaceutical Use

d- Methamphetamine hydrochloride (Desoxyn®) is prescribed for obesity (short-term treatment) and Attention Deficit Disorder with Hyperactivity (ADHD).

V. Chemical Hazards

A. Reactivity

Methamphetamine hydrochloride is stable at normal temperatures and pressure (MDL, 2001).

B. Flammability

Methamphetamine hydrochloride is a slight fire hazard. Dust in air may ignite or explode (MDL, 2001). Hazardous combustion or decomposition products include carbon monoxide, carbon dioxide, and nitrogen oxides. Combustion of methamphetamine hydrochloride may produce hydrogen chloride gas (Sigma, 2002).

C. Chemical Incompatibilities

Methamphetamine is incompatible with strong oxidizing agents (Sigma, 2002; MDL, 2001).

VI. Health Hazards

A. General

Methamphetamine hydrochloride can be inhaled (smoked), snorted, injected, or ingested (Turkington, 2000). The route of exposure primarily affects the rate of absorption and onset of effects, with injection and inhalation producing the most rapid onset, and ingestion resulting in delayed onset. **In general, once methamphetamine is absorbed, the biological effects are the same regardless of the route of exposure.**

Effects of methamphetamine exposure vary widely and depend on a number of individual factors. For example, age is an important determinant of symptomology; adults and children differ markedly in response to the drug. Dose, as well as the frequency and duration of exposure, may also affect the range of symptoms reported. Repeated exposure may lead to development of tolerance to one or more effects, and symptoms resulting from withdrawal differ dramatically from those that are usually associated with methamphetamine exposure. For these reasons, it may be misleading to classify methamphetamine simply as a nervous system stimulant. The signs and symptoms summarized below provide a range of potential effects that may result from exposure to methamphetamine.

B. Acute Effects

Methamphetamine hydrochloride increases wakefulness, mental alertness, and physical performance (MDL, 2001). However, methamphetamine may impair the ability to perform hazardous activities that require concentration and physical coordination (Makalinao & Aguirre, 1993). Severe fatigue and depression generally follow central nervous system stimulation (MDL, 2001).

Acute effects include nervousness, hyper-excitability, hyperactivity, irritability, assaultiveness, compulsive or repetitive behavior, euphoria, insomnia, tremor, restlessness, headache, drowsiness, fatigue, exacerbation of motor and phonic tics, and Tourette's syndrome (uncontrolled movement of the head, neck, arms, and legs) (PDR, 2002; USP, 1998; HSDB, 2002; MDL, 2001). Additional symptoms of methamphetamine exposure include blurred vision, loss of appetite, weight loss, lightheadedness, increased sweating, urticaria (intense itching of skin), ulcers of the lips and tongue, impotence, changes in libido, chest pain, and unpleasant taste (PDR, 2002; USP, 1998; HSDB, 2002). Acute intoxication from methamphetamine can cause central nervous system stimulation, dizziness, headache, dryness of mouth, metallic taste, teeth grinding, anorexia, insomnia, tremor, rash, chest pain, difficulty breathing, fainting, blurred vision, dilated pupils, cyanosis (bluish skin color due to lack of oxygen), lung congestion, convulsions, coma, and respiratory failure (MDL, 2001; Sigma, 2002). Gastrointestinal symptoms of methamphetamine exposure include nausea, vomiting, diarrhea, abdominal cramps, constipation, or pain (PDR, 2002; USP, 1998; HSDB, 2002). Methamphetamine can be irritating to skin, eyes, mucous membranes, and the upper respiratory tract (Sigma, 2002).

High doses of methamphetamine cause irritability, paranoia, withdrawal, and severe depression (Turkington, 2000). Psychotic episodes (rare at prescribed doses on the order of 5-25 mg/day) may result from exposure to methamphetamine (PDR, 2002). Psychological dependence and tolerance usually occur following prolonged use or high doses (USP, 1998). Methamphetamine exposure may also cause cerebral infarction (localized oxygen deprivation, resulting in death of brain tissue and neurological deficit) and hemorrhage (bleeding) (Klaasen, 2001). Methamphetamine hydrochloride poisoning may ultimately result in collapse, shock, systemic acidosis (accumulation of acid in the body), coma, and convulsions (MDL, 2001).

Cardiovascular effects from methamphetamine exposure include arrhythmias (irregular heartbeat), hypertension (high blood pressure), hypotension (low blood pressure), circulatory collapse, tachycardia (rapid heart beat), palpitation (readily noticeable rapid, irregular, or forceful beating of the heart), fainting, and cardiomyopathy (degeneration of heart muscle) (PDR, 2002; USP, 1998; HSDB, 2002; MDL, 2001).

In addition, over-doses of methamphetamine may cause hyperreflexia (exaggeration of reflexes), rapid respiration, confusion, aggressiveness, hallucinations, panic states, hyperpyrexia (highly elevated body temperature), rhabdomyolysis (disintegration of skeletal muscle), fatigue, depression, acute paranoia, and a state resembling schizophrenia (PDR, 2002; Craig, 1995; Turkington, 2000). High environmental temperature may enhance the toxic effects of methamphetamine (MDL, 2001).

Intravenous injection of methamphetamine base causes necrosis of tissue at the injection site (Turkington, 2000).

C. Chronic Effects

Chronic exposure to methamphetamine hydrochloride may cause the following: severe dermatoses, insomnia, irritability, hyperactivity, personality changes, weight loss, poor concentration, grinding of the teeth, ulcers of the lips and tongue, anxiety, fear, compulsive/repetitive behavior, and possible self-injury (MDL, 2001; PDR, 2002). Prolonged use of high doses of methamphetamine hydrochloride may result in a psychotic syndrome resembling schizophrenia. This condition is characterized by anxiety, fear, paranoid delusions, and visual, tactile and auditory hallucinations, which may include the imaginary infestation of bugs or small vermin. Attempts to remove these imaginary organisms may result in severe skin lesions. There may also be brief periods of delirium and disorientation. Confusion, memory loss, and persistent delusional ideas may occur during psychoses recovery. Prolonged use results in tolerance and psychological and physical dependence. Withdrawal can occur from abrupt cessation of high doses resulting in mental depression, fatigue, vomiting, and nausea (USP, 1998; MDL, 2001).

D. Skin Contact

Methamphetamine may be irritating to skin (Sigma, 2002).

E. Eye Contact

Application of amphetamines to the eye may cause pupil dilation and retraction of the upper lid (MDL, 2001).

F. Inhalation

See sections VII, A and VII, B above.

G. Ingestion

See sections VII, A and VII, B above.

H. Predisposing Conditions

The harmful effects of methamphetamine exposure may be exacerbated by the following pre-existing conditions: hormonal disorders, agitated states, advanced arteriosclerosis, cardiovascular disease, history of drug abuse or dependence, glaucoma, hypertension, hyperthyroidism, psychoses, Tourette's syndrome, or other motor or vocal tics. Exaggerated

effects may occur if methamphetamine exposure occurs within fourteen days of administration of monoamine oxidase inhibitors (MAOI). Persons with a previous history of hypersensitivity or idiosyncrasy to sympathomimetic amines are likely to be more sensitive to methamphetamine (HSDB, 2002; USP, 1998; MDL, 2001).

I. Special Concerns for Children

Long-term use of stimulants in children has reportedly caused suppression of growth (PDR, 2002). Amphetamine passes into breast milk and can be detected in a breast-fed infant's urine. In a study of sixty-five children whose mothers were addicted to amphetamine during pregnancy, growth, physical health, intelligence, and psychological function were all within normal range at eight years of age. However, children whose mothers were exposed throughout pregnancy tended to be more aggressive (Makalinao & Aguirre, 1993).

VII. First Aid

A. Eyes

In case of contact with eyes, flush with plenty of water for at least fifteen minutes, lifting and separating the eyelids with fingers to assure adequate flushing. Obtain medical attention (Sigma, 2002; MDL, 2001).

B. Skin

Wash skin with soap and water for at least fifteen minutes and remove contaminated clothing and shoes. Seek medical attention if needed (MDL, 2001).

C. Ingestion

Contact the local poison control center or a physician immediately. Wash out mouth with water if person is conscious; never make an unconscious person drink fluids or vomit (MDL, 2001; Sigma, 2002). However if vomiting does occur, keep head lower than hips to help prevent aspiration. Turn affected person's head to the side if unconscious (MDL, 2001).

D. Inhalation

If inhaled, remove to uncontaminated area. Give artificial respiration if not breathing. If breathing is difficult, give oxygen. Obtain immediate medical attention (MDL, 2001).

VIII. Standards for Inhalation Exposure

A. Occupational Exposure Limits (NIOSH, 1997; ACGIH, 1994)

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|--|------------------|
| 1. Ceiling Limit (C) (not to be exceeded at any time): | Not established. |
| 2. Short-Term Exposure Limit (STEL or ST): | Not established. |
| 3. 8-Hour Time Weighted Average (TWA): | Not established. |
| 4. 10-Hour Time Weighted Average (TWA): | Not established. |
| 5. Immediately Dangerous to Life & Health (IDLH): | Not established. |

Important Definitions Follow:

Ceiling Limit (C) is a concentration that must not be exceeded during any part of the workday.

Short-Term Exposure Limit (STEL or ST) is a 15-minute time-weighted average concentration that should not be exceeded during any part of the workday.

8-Hour Time Weighted Average (8-hour TWA) concentration is an exposure standard that must not be exceeded during any 8-hour work shift of a 40-hour workweek. 8-Hour TWA exposure standards established by the Occupational Safety and Health Administration (OSHA) are called Permissible Exposure Limits (PELs). 8-Hour TWA exposure standards established by the American Conference of Governmental Industrial Hygienists (ACGIH) are called Threshold Limit Values (TLVs).

10-Hour Time Weighted Average (10-hour TWA) concentration is an exposure standard that must not be exceeded during a 10-hour workday of a 40-hour workweek. 10-Hour TWA exposure standards developed by the National Institute for Occupational Safety and Health (NIOSH) are called Recommended Exposure Limits (RELs).

Immediately Dangerous to Life & Health (IDLH) defines a concentration which poses a threat of death or immediate or delayed permanent health effects, or is likely to prevent escape from such an environment in the event of failure of respiratory protection equipment. IDLH values are developed by the National Institute for Occupational Safety and Health (NIOSH).

“Skin” notation (NIOSH): significant uptake may occur as a result of skin contact. Therefore, appropriate personal protective clothing should be worn to prevent dermal exposure.

B. Emergency Response Planning Guidelines (1 hour or less) (AIHA, 2002)

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|--|------------------|
| 1. ERPG-1 (protective against mild, transient effects): | Not established. |
| 2. ERPG-2 (protective against serious adverse effects): | Not established. |
| 3. ERPG-3 (protective against life-threatening effects): | Not established. |

Emergency Response Planning Guidelines (ERPGs) are developed by the American Industrial Hygiene Association (AIHA) to assist in planning and preparation for catastrophic accidental chemical releases. ERPGs allow emergency response planners to estimate the consequences of large-scale chemical releases on human health, and evaluate the effectiveness of prevention

strategies and response capabilities. ERPGs assume that the duration of exposure is one hour or less. They are not intended to be used as limits for routine operations and are not legally enforceable.

Definitions for the three ERPG levels are:

ERPG-1: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing more than mild, transient adverse health effects or without perceiving a clearly defined objectionable odor.

ERPG-2: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing irreversible or other serious health effects or symptoms that could impair an individual's ability to take protective action.

ERPG-3: an estimate of the maximum airborne concentration below which nearly all individuals could be exposed for up to one hour without experiencing or developing life-threatening health effects.

C. Acute Reference Exposure Level (1-hour exposure) (OEHHA, 1999)

Level protective against mild adverse effects: Not established.

D. Chronic Reference Exposure Level (multiple years)(OEHHA, 2002)

Level protective of adverse health effects: Not established.

Reference Exposure Levels (RELs) are developed by the California EPA's Office of Environmental Health Hazard Assessment (OEHHA). A REL is a concentration at or below which no adverse health effects are anticipated, even in the most sensitive members of the general population (for example, persons with pre-existing respiratory disease). RELs incorporate uncertainty factors to account for information gaps and uncertainties in the toxicological data. Therefore, exceeding a REL does not necessarily indicate an adverse health impact will occur in an exposed population. Acute RELs are based on an assumption that the duration of exposure is one hour or less. Chronic RELs are intended to be protective for individuals exposed continuously over at least a significant fraction of a lifetime (defined as 12 years).

E. Chronic Reference Concentration (lifetime exposure) (IRIS, 2003)

Level protective of adverse health effects: Not established.

IX. Environmental Contamination Concerns

A. Surface Water

No information available.

B. Groundwater

No information available.

C. Drinking Water

No information available.

Suggested No Adverse Response Level (NAS, 1980): Not established.

Preliminary Remediation Goal for Tap Water (U.S.EPA, 2002 Region IX): Not established.

D. Soil

No information available.

Preliminary Remediation Goal for Residential Soil (U.S. EPA, 2002 Region IX): Not established.

E. Air

No information available.

Preliminary Remediation Goal for Ambient Air (U.S. EPA, 2002 Region IX): Not established.

F. Indoor Surface Contamination

Methamphetamine base is volatile and would not be expected to persist on indoor surfaces. Methamphetamine hydrochloride is a salt and may persist on surfaces. A number of states have developed clean-up standards for methamphetamine contamination on indoor surfaces, ranging from 0.1 to 5 µg methamphetamine per square foot of surface area. None of these standards is based on the toxicity of methamphetamine (i.e., identification of a threshold exposure) or estimates of the potential exposure that might result from contact with methamphetamine-contaminated surfaces. In addition, validated methods for quantifying the amount of methamphetamine residue on surfaces have not been established. The California Environmental Protection Agency Office of Environmental Health Hazard Assessment is currently developing a risk-based cleanup advisory standard for methamphetamine on indoor surfaces and evaluating methods of assessing the level of methamphetamine contamination on surfaces.

X. Personal Protective Equipment

Wear splash resistant chemical safety goggles. Wear appropriate chemical resistant clothing and gloves. If entering an area of unknown concentration, wear a supplied air respirator with full face-piece operated in a pressure-demand or other positive pressure mode in combination with a separate escape supply. Thoroughly wash exposed areas after handling. Clean and dry contaminated clothing and shoes before reuse (MDL, 2001).

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